



Title of the Invention:

METHOD OF MANUFACTURE

(MANUFACTURING METHOD) OF STRUCTURAL BODY AND

STRUCTURAL BODY

5 Background of the Invention:

<Technical Field to which the Invention Belongs>

The present invention relates to a method of manufacturing ^{a unitary} (one) structural body (by joining ^{body members}), without a gap, from plural (forming products) having a flange ^{by joining} to an end portion ^{to an end portion of} of one plate (and) another plate ^{and}, in particular, to a ^{method of} manufacture suitable for ^{production of} an end structure (for) constituting (a longitudinal direction) end portion of a railway vehicle. ^{the invention relates}

<Prior Art>

As shown in Japanese patent No. 2,692,459 (USP No. 5,488,770), a car body of a railway vehicle ^{typically} has a hexahedron ^{-shaped} body. An (longitudinal direction) end portion of the railway vehicle is ^{referred to} (called) as an end structure. ^{the} (To) the end structure, ^{there is provided} a passage ^{or door} for (coming and going) to an adjacent car (body is provided).

For this reason, the end structure ^{requires} (necessaries) two plates (for) constituting a right side ^{panel on the} passage and a left side ^{of the} passage and a plate for constituting ^{a panel above} (an upper portion) (of) the passage. Since the three plates join a roof structural body ^{member} and a side structural body ^{member}, (to the end) (portion of) the outer sides ^{edges} of the three plates ^{each} have (respectively the) flange. Further, the end portions of the three plates have (the) reinforcement (use) flanges.

In the prior art, [the forming] ^{a in the form of a plate} product, having (the) ^{along a side} flange, [to the end portion] of the plate is manufactured by (the) ^{forming,} press (manner), in which the plate is placed between a female die and a male die. Since (the) ^{required for such processing, the cost of manufacturing} female die and (the) ^{male die} male die are [necessitated and then it] becomes (the) high (cost).

For the above reason, [to the] respective [plate] L-shaped plates ^{are} [is] welded (according to a) ^{using} spot welding (manner) and one side of ^{the} L-shaped plate ^{forms} [is formed as] the above-stated flange.

As a means for [lessening] ^{avoiding} the ^{need for a male} metal die, a forming ^{using only a female die} method ^{has been} proposed, as shown in [from] Fig. 18 to Fig. 20 of Japanese application patent laid-open publication No. Hei 11-310,371. In this method, ^{on} (to) the female die, an outer peripheral portion of a ^{plate of raw} (row) material is fixed and the ^{raw} (row) material is pushed in ^{according} ^{using} a rod-shaped tool, ^{moving} (and) along ^{to} (to) an inner peripheral face of the female die. The tool is moved and the plate is ^{subjected} [carried out] ^{to} incrementally, a buckling processing.

On the other hand, in Japanese application patent laid-open publication No. Hei 10-76,321, ^{a method is disclosed in which} a squeezing processing is carried out incrementally.

^{by way of example} (A) construction shown in Fig. 13 will be explained. ^{On} (To) three plates 1, 2, 3, after flanges 1b, 1c, 1d, 2b, 2c, 2d, 3b, 3c, 3d have ^{been} provided. The flanges 1b, 2b of the right and the left plates 1, 2 are overlapped, and these ^{1b} flanges ^{are} ^{subjected} [carried out according] to (the) spot welding and are formed as one body. The flanges ^{are} (is) provided ^{as an integral part of the} as [one] body by bending the plates 1, 2, 3. Further, the

flanges 1c, 3c, 2c are overlapped ^{by} to a roof structural body 30 and welded.

³⁴ reference numeral 45 ^{denotes} is a ^{passageway for} passenger of passengers.

The respective three plates 1, 2, 3 are continued to the adjacent flange and ^{the} connection portion has a circular arc shape. In this case, to a joining portion between the right and the left plates 1, ³ 2, the central plate ² 3 and the roof structural body 30, a space exists. This space must

be closed with another plate to prevent ^{and other elements from entering the space} the entering the rain, water etc). The closing work ~~work~~ requires ^a the high cost. Further, ^{the} outer appearance becomes ^{unattractive} bad.

Further, the flanges ^{are} ~~is~~ formed by bending the plate, ^{so that} a cross-section thereof has the circular arc shape. For this reason, a groove is provided between the right and left plates, ^{with the result that} accordingly, the outer appearance becomes ^{unattractive} bad.

In the increment ^{al} forming method, since the metal die ^{in the form of a single} is made by one die, the manufacture can be carried out with ^a the low cost. However, in the increment ^{al} forming method, ^{as described} shown in the above-stated Japanese application patent laid-open publication Hei 11-310,371, ^{the flange is formed} to the end portion the flange is formed, but the plate is left on the outer peripheral portion of the flange. ^{thus,} In a case where the plate is unnecessary, it is necessary to cut off and remove the outer peripheral portion of the flange.

Further, according to this increment ^{al} forming method, when the flange is formed, the angle ^{between} by making the flange and the bottom plate is not made with the ^a right angle,

however it works. For example, when a cylinder is joined by overlapping the flange, ^{and} the flange has ^a ~~the~~ right angle, ^{is difficult} it ~~can hardly~~ to carry out ~~the~~ overlapping joining.

Further, it is difficult to form ~~the~~ ^a flange having ^{a substantial} ~~the high~~ height. For this reason, ~~to the flange~~ it is difficult to overlap ^{the flange of one} ~~another~~ member and a flange of ~~the~~ another member.

On the other hand, according to the processing method ^{described} ~~(shown)~~ in the above-stated Japanese application patent laid-
 10 open publication No. Hei 10-76,321, when the flange is processed, ^a ~~the~~ wrinkle can occur easily in the joining portion between the ^{one} flange and the ^{other} flange.

Summary of the Invention:

15 An object of the present invention, ^{is characterized} ~~resides~~ in that, when two plates having a flange and a third plate are joined, ^{the} ~~an~~ occurrence of a space in a joining portion can be prevented.

The above-stated object can be attained by a ^{manufacture of} ~~manufacturing~~ method of a structural body, ^{which includes the steps of producing} ~~manufacturing~~ a
 20 ~~manufacturing~~ first plate and a second plate, for abutting and welding the first plate, the first plate comprising a first flange provided by bending a first side of the first plate, a
^{which is substantially} second flange ~~(being)~~ orthogonal ~~(substantially)~~ to the first
 25 flange and, ^{is} provided by bending a second side of the first plate, and a recessed portion ^{where there is no} ~~(except for a)~~ flange between an end portion in a longitudinal direction of the first

flange and an end portion in a longitudinal direction of the second flange, the second plate comprising a third flange provided by bending a first side of the second plate and for connecting the end portion in the longitudinal direction of the first flange, and a raised portion ^{which} protrudes ^S from a third side, which ^{substantially} is ^{and} orthogonal ^(substantially) to the first side ⁽ⁱⁿ⁾ a second side being parallel substantially to the first side and in an end portion in a longitudinal direction of the third flange and in a vicinity of the end portion ^(b) abutting the end portion in the longitudinal direction of the first flange and the end portion of the longitudinal direction of the third flange ^(b) abutting the third side to an outer side of a circular arc of the second flange from the first plate ^(b) inserting and abutting the raised portion to the recessed portion ^(b) and welding the respective abutted portions.

Brief Description of the Drawings:

Fig. 1 is a ^{plan} rear face ^{representing} view of an end structure of a car body ^(of) one embodiment according to the present invention;

Fig. 2 is (II-II) cross-sectional view ^{taken along line II-II in} ^(of) Fig. 1;

Fig. 3 is (III-III) cross-sectional view ^{taken along line III-III in} ^(of) Fig. 1;

Fig. 4 is an enlarged view of ^a (IV) portion ^{IV in} ^(of) Fig. 1;

Fig. 5 is (V-V) cross-sectional view ^{taken along line V-V in} ^(of) Fig. 4;

Fig. 6 is a perspective view of an end structure of a car body ^{representing} ^(of) one embodiment according to the present

invention;

Fig. 7 is a longitudinal cross-sectional view of (an) ^a (essential) portion of an incremental^{of the area} forming apparatus;

Fig. 8 is a plan view^{at} between a flange 52b and a ^{point} flange 52c ^{process} (in) a midway of the forming;

Fig. 9 is a plan view of an end portion in a longitudinal direction of a flange ^{at} (in) a midway^{point} of the forming^{process};

Fig. 10 is a plan view of a circular arc portion ^{at} (in) a ^{point} midway^{process} of the forming;

Fig. 11 is a ^{plan} (front face) view of an end structure of a car body ^{representing} (of) another embodiment according to the present invention;

Fig. 12 is ^{taken along line XII-XII in} (XII-XII) cross-sectional view (of) Fig. 11;

and

Fig. 13 is a ^{diagram of the construction} (view) corresponding to ^{the end structure of} Fig. 1 ^{as provided} in ^{construction} (the) ^a prior art.

Description of the Invention:

A first embodiment of a ^{method of} manufacturing (method of) a structural body according to the present invention will be explained ^{with reference to} (referring from) Fig. 1 to Fig. 12. ⁶ Fig. 1 shows mainly a (left) ^{new} half portion of a car body. The car body comprises a stand flame 10 (for) constituting a floor, a side structural body 20 (for) constituting a side face, a roof ^t structural body 30, and an end structural body 40 for closing ^{the new} (an) end portion of the car body.

As seen in Fig. 1,

The end structural body 40 comprises a passage 45 for the passengers, a plate 50 [for] constituting a left side thereof, a plate 60 [for] constituting a right side thereof, and a plate 70 [for] constituting an upper portion ^{above} [of] the passage 45.

The right and the left plates 50 and 60 are, of substantially quadrang^{ular} shape, and to ^{the edge} [an end] portions, except ^{the bottom edge of each} for ^a [a side of a lower end of the] plate, flanges 52b, 52c, 52d, 62b, 62c, 62d are provided. The flange 52b (62b) is ^{which is on one} (the) flange [in a] side of the passage 45. The flange 52c (62c) is ^a [the] flange which overlaps [to] the roof structural body 30. The flanges 52d, 52e (62d, 62e) are flanges which overlap [to] the side structural body 20.

^{At} [To] a joining portion ^{disposed between} [of] the ^{end of} (an) upper end of the vertical flange 52b (62b) and the ^{two, two} flange 52c (62c) ^{in which} [of the] (upper side), no flange is provided. ^{As seen in Fig. 4,} The flanges form a non-continuous portion. In this portion, ^{the} no flange is provided. ^{cut out and} (but) a portion of ^a [a bottom] plate 51 (61) is ^{formed thereby} [excepted], a quadrang^{ular}-shaped recessed portion 53 (63) is ^{provided}. (A) ^{later} size of the recessed portion 53 (63) will be described [in a] [latter portion].

The plate 70 [for] constituting the upper portion ^{above} [of] the passage 45 for the passengers is, substantially quadrang^{ular} shape and has flanges 72b and 72c ^{along} [in] the lower side and the upper side. ^{respectively, as seen in Fig. 3} The flange 72c is [the flange] ^{mounted so that it} [which] overlaps [to] the roof ~~structural~~ structural body 30. ^{As seen in Fig. 5,} End portions ^{on the} [of a] left side 71b and a right side 71c

of the plate 70 are abutted ^{against the} to a bent circular arc-shaped outer face ^{at} in which the flange 52b (62b) protrudes from the ^{portion} bottom plate 51 (61). This abutted portion is ^{subjected to} carried out ^{portion} the welding. The ^{portion} bottom plate 51 (61) of the plate 50 (60) is ^{coextensive with the plate portion of the} the same face of a bottom plate 71. Further, this ^{performed by} abutting welding is called as a fillet welding ^{manner}.

The right and the left end portions of the flange 72c and the plate ^{portion 71} in the vicinity of the flange ^{each have an extension} provide raised portion 73, ^{as seen in Fig. 4,} which enter the recessed portion 53 (63) of the plate 50 (60). ^{The} An abutted ^{ing} portion between the recessed portion 53 (63) ^{and} of the ^{extension} raised portion 73, 73 is welded. ^{At} An upper ^{edge} side of the ^{extension} raised portions (73, 73, forms the flange ^{continues} 72c. The ^{end of the} flange 52c (62c) and the ^{as seen in Fig. 4} longitudinal direction end portion of the flange 72c are abutted and welded.

The ^{on} longitudinal direction end portions of a lower side 72b of the plate 70 ^{or} is abutted ^{against} to the flanges 52b, 62b and welded. An end portion of the bottom plate 71 between the ^{extension} raised portions 73 and the flange 72b protrudes from the longitudinal direction end ^{portion} of the flange 72b.

The abutted portions ^{described} in above are welded continuously ^{so that} and no water leakage occurs. The welded ^{ed} portions are cut off by a grinding ^{manner} and are formed smoothly.

The flange 52e (62e) ^{forming} of the connection portion between the flange 52c (62c) and the flange 52d (62d), ^{forms} has a circular arc shape.

The ^{directions of} protrusion ^{directions} of the flanges 52b, 52c, 52d, 52e, 62b, 62c, 62d, 62e, 70b, 70c are ^{substantially} orthogonal

[substantially] to the faces of the [bottom] plates ^{portions} 51, 61, 71. Accordingly, when the flanges 52c, 52d, 52e, 62c, 62d, 62e, 70c are overlapped to an inner side of the end portions of ^a (the) side structural body 20 and the roof structural body 30, they overlap in parallel ^{so that} [and the] good welding can be attained. The lower ends of the right and the left plates 50, 60 are overlapped ^{on} [to] the stand frame 10 and are welded.

The plates 50, 60, 70 have a plurality of reinforcement [use] ribs ^{on} [in] the inner side of the car body and ^{on} [in] the outer side of the car body, but they are not shown in the figure. For example, ^a [the] rib ^{may be} [is] formed of another member ^{spot welded to} [with] the plates 50, 60, 70 [the spot welding] ^{manner} is carried out. Further, the plates 50, 60, 70 are provided integrally by [the] plastic processing.

According to the above, ^{at the point} [to the joining] portion between the plate 70, the plate 50 (60) and the roof structural body 30, there is no gap ^{after} [and then the] joining is carried out. Further, ⁱⁿ ^{joint} [to the joining] portion, between the plate 70 and the plate 50 (60), there is no circular arc-shaped groove of the flange ^{so that a} [and the] good outer appearance can be obtained.

Next, the method ^d [for] manufacturing the plates 50, 60 and 70 will be explained ^{with reference} [referring] to [from] Fig. 7 to Fig. 10. This plate manufacturing method is carried out according to the increment ^d forming method. Fig. 7 shows ^S only a left end portion of the increment ^d forming apparatus. The other portions have suitably the same construction.

The forming of the plate 50 will be explained, ^{by way of example} A
 metal die 120, ^{which represents} (is) a female die (an outer die). The female
 (die 120), ^{disposed} is (placed) horizontally. ^{On} (To) an upper face of the
 female die 120, ^a (the) plate 50 (being the raw) material is
 5 mounted. ^{Into} (In) an interior portion of the female die 120, a
 rod-shaped tool ¹³⁰ (120) is inserted. The tool 130 ^{is lowered by an incremental amount} (descends),
 along (to) a vertical face of the female die 120, and (next) ^{then it is}
 moved ^{circumferentially} along (to) an ^{the} inner peripheral face of the female die
 120. ^{the} (A) shape of the inner peripheral face of the female
 10 die 120 ^{corresponds to the desired} (is the same) outer diameter shape of the plate 50.
 When the tool 130 ^{has been moved entirely around the inside of the female die 120} (is carried out to go one round), the
 tool 130 ^{is incrementally lowered again and is repeated} (repeats) the above function. Accordingly, the flat
 plate 50b (being the raw) material is ^{subjected to} (carried out the)
 squeezing processing. Further, the ^{descending movement} (descendant), of the tool
 15 130 ^{is a} (means the) movement in the squeezing processing
 direction. This is substantially (the) ^a movement in (an) axial
 direction of the tool 130 and is (the) ^{the} movement in (a) depth
 direction of the ^{being formed} (forming) product.
 (A) ^{the} tip end of the tool 130 is flat. A corner portion, and
 20 from the tip end to the side face of the tool 130, ^{the surface} has a
 circular arc shape. ^{to form a corner portion} The circular arc ^{-shaped portion forms the flanges 52b, 52c, 52d} (is) a circular arc,
 (which is formed by a) ^{as the flat tip end rests on the} bottom plate 51 of the plate 50 (and)
 (the flanges 52b, 52c, 52d). The tool 130 is ^{lowered} (lifted) down
 (rotatively from the movement) ^{while it is allowed to rotate with a} body (not shown in figure) (of) ^{coupled to}
 25 the upper portion. The tool 130 ^{of the tool} moves ^{also circumferentially} along (to) an inner
 peripheral face (it) ^{which} corresponds to the portions (of) ^{where} the
 flange ^{are formed} 52b, 52c, 52d) of the female die 120.

Since the tool 130 moves by contacting ^(to) the ^{raw} material 50b, the tool 130 rotates (rotates on its axis) as a follower. Accordingly, the tool 130 is not ⁱⁿ contact ~~and~~ ^{at only} one point ^{with} ^{raw} the ^{so that} material 50b, a blazing phenomenon can
 5 be prevented. Further, a lubricating oil is coated on the upper face of the ^{raw} material 50b.

On the upper face of the female die 120, plural positioning ^(use) pins (guides) 123 are ^{mounted} ^{stood up}. When the flat plate of the ^{raw} material 50b is placed on the upper
 10 ^{surface} ^(end) of the female die 120, the pins 123 contact ^(to) the outer peripheral ^{edges} ^{raw} portion of the material 50b. Then the ^{so that accurate} positioning is carried out. The upper end ^(it is) called ^(as) a shoulder portion of the inner peripheral side of the female die 120 has ^{the shape of} a circular arc. This circular arc
 15 exists along the whole periphery of the female die 120.
 According ^{Due} to this circular ^{shape} arc, the outer peripheral portion of the ^{raw} material 50b moves smoothly ^{into} the ^{inner} inside ^{when pressed by the tool 130} (peripheral side) of the female die 120. [Further,] The position etc. of the circular arc portion of the shoulder
 20 portion of the female die 120 will be ^{further} described ^{later} in a latter portion.

The interior portion of the female die 120 has no bottom ^{open} portion. In the ^{is provided} interior portion of the female die 120, a seat 140 ^{raw} for mounting the material 50b ^{by a mechanism} (is) ^{operations} provided. The seat 140 is supported ^{according to a means} 150 which can carry out ^{to control the height position} thereof. The seat 140 is provided ^{in a location} on a portion which

opposes ^{the} (to a) tip portion (a) lower end) of the tool 130.

The seat 140 is provided on a portion which corresponds to a ^{extending} (move) track in the peripheral direction of the tool 130. →

Namely, the ^{raw} (row) material 50b is sandwiched by the tip
 5 end of the tool 130 and the seat 140. Further, the seat 140 is provided ^{in the} on a ^{open area} central (portion) of the female die 120. Accordingly, the central portion of the ^{raw} (row) material 50b can be ^{supported on the seat 140} fixed.

The seat 140 ^{supports} (mounts) the ^{raw} (row) material 50b and fixes it ^{in position}.
 10 The fixing is carried out ^{using} (according to the) magnetic force (by) providing ^{ed} an electromagnet. Or, on an upper face of the seat 140, a vacuum adsorption pad ^{maybe} (is) provided ^{substantially} (and) the fixing is carried out ^{using} (according to a) vacuum adsorption. (A) ^{located at} the fixing position is a central portion of the seat 140. The
 15 ^{raw} (row) material 50b is made of a steel system metal, a stainless system metal, and an aluminum alloy system metal.

The means 150 for ^{raising} (ascending) and ^{lowering} (descending) the seat 140 will be explained. The means 150 is comprised of plural screw mechanisms 151. In Fig. 7, ^{one of} a pair of the screw mechanisms 151 is shown. A seat 145 ^{disposed below} (of a lower end) ^{on} (of) the seat 140 is supported (according to) a screw rod 152. ^{On} (To) the seat 145, a rotatable free nut ^{which engages with the screw rod 152} is provided. →

^{With} (According to) the rotation of a drive mechanism 155, the screw 152 rotates and the seat 140 ^{is lowered or raised} (descends). Further,
 25 between the seat 140 or the seat 145 and a base, plural ^{vertically guiding the raising} guides (not shown in figure) for ^{lowering} (ascending) and (descending) ^{if} (vertically) the seat 140 are provided. The means 150 and

the female die 120 are ^{supported} installed on the base.

The ^{incremental} forming method will be explained. The (row) ^{raw} material 50b is a flat plate, which is developed ^{into} (as) a ^{desired size and} shape ^{based on the product to be formed} after the forming. In the above-stated development, the ^{of the plate} development size is calculated according to the surface area and the volume of the ^{to be formed} (forming) product, similar to the squeezing forming method of the corner portion. Or, it is determined according to ^{the} experimentation.

^{On the basis} Under the base ^{set} of the development size, the plate is cut off using a tartlet punch press (manner) etc. (A), ^{dummy} which ^{the bridging} (connection) portion between the flange 52b and the flange 52c is ^{removed} separated. Further, the recessed portion 53 is ^{cut out} provided. The development shape of the (row) ^{raw} material 50b is determined according to the above-stated ^{raw} ^{factors} facts.

15 Next, the (row) ^{raw} material 50b is mounted on the upper ^{side} (end) of the female die 120. ^{at} In this time, the ^{raw} material 50b is ^{supported} mounted on the (ascended) seat 140. The row material (50b) is positioned ^{ed} (determined) by ^{the} a pins 123.

20 ^{They} Next, the (row) ^{raw} material 50b is fixed to the seat 140 ^{at a central portion thereof using a magnetic force or vacuum adsorption, as} (The fixture position and the fixture means are) ^{previously} stated (on) the former portion.

Next, the seat 140 ^{lowered by an incremental amount} is descended and (next) the tool 130 ^{then lowered} is descended. (A ^{the} descendent) position ^{to which} (of) the tool 130 ^{is lowered} is a position where (between) the side face of the tool 130 and the vertical face (the inner peripheral face, the linear portion) of the female die 120, ^{face each other with} the (row) ^{raw} material 50b ^{therebetween} is positioned.

5 ^{no R} Namely, the ^{raw} [row] material 50b is sandwiched between
 the inner peripheral face of the female die 120 and the
 side face of the tool 130. Under this condition, [the tool]
 [130 is descended and as stated in a latter portion] the tool
 130 is moved ^{circumferentially} in the peripheral direction along ^{to} the inner
 peripheral face of the female die 120. [A descendent] ^{by which} amount
 (of) the tool 130, ^{is lowered} is [one where a] ^{such that the} tip end of the tool 130
 contacts [to] the ^{raw} [descendent row] material 50b.

For example, before the ^{lowering} [descendent] of the seat 140,
 10 when the upper face of the seat 140 is positioned at the
 same ^{level as} [face of] the upper face (the ^{on which} [position where] the end
 portion of the ^{raw} [row] material 50b is mounted [on] of the
 female die 120, when the tip end of the tool 130 is ⁱⁿ
 contact ^{with} (to) the upper face of the ^{raw} [row] material 50b, ^{lowered by} (the)
 15 [descended amounts of] the seat 140 and the tool 130 are ^{the}
 same ^{incremental} amount. Both [of] the seat 140 and the tool 130 can be
^{lowered} [descended] at the same time.

(As shown) In this embodiment according to the present
 invention, ^{if} [when] the bottom plate 51 is wide and the plate
 20 thickness is thin and the central portion of the bottom
 plate 51 is fixed, since the bottom ^{portion} plate 51 is bent, it is
 unnecessary to bend the outer peripheral portion of the
 bottom plate ^{portion} 51 according to ^{the shaped} the female die 120.
 Accordingly, the ^{raw} [row] material 50b may ^{thus} [become] to incline.
 25 Further, as stated in a latter portion, when the tool 130
 is moved ^{circumferentially} in the peripheral direction, the ^{raw} [row] material 50b
 may ^{thus} [become] to rotate. Accordingly, the ^{raw} [row] material 50b is

fixed to the seat 140.

The ^{to which} ~~descendent~~ ^{lowered is} position, ^{the flanges 52b, 52c and 52d begin to be formed} of the tool 130 is, a position ~~in~~ in which, between the side face of the tool 130 and the inner peripheral face of the female die 120 [the] flanges 52b, 52c and 52d are positioned. Further, [it is] ^{is given to} taken into the consideration, ^{so as} about the rectangular angle of the flanges 52b, 52c, 52d. When the rectangular angle is taken into [the] consideration, the tool 130 is positioned ^{raw} to sandwich the [row] material 50b between the side face of the tool 130 and the inner peripheral face of the female die 120.

Next, the tool 130 is moved ^{circumferentially} along [to] the inner peripheral face of the female die 120. The tool 130 rotates ^{at this time} as a follower. The ^{raw} [row] material 50b is formed ^{progressively} incrementally ^{circumferential} in accordance with the movement of the tool 130.

^{time} ^{has been through one cycle} [Next,] Every the tool 130 ^{is} moved, around [one] ^{the} periphery, ^{in this way} [as stated in above], the seat 140 is ^{lowered} descended, and [also] the tool 130 ^{also lowered} is ^{are moved} descended. The ^{incremental} ^{by which} descendent amounts, [of] the tool ¹³⁰ and the seat 140, and the ^{stated} ^{then} descendent position of the tool 130 are ^{circumferentially} [the sated in] above. ^{once again} [Next], the tool 130 is, moved ^{circumferentially} along [to] the inner peripheral face of the female die 120.

^{Thereafter} ^{incremental lowering} ~~the tool 130~~, the ^{circumferential} descendent of the seat 140 and the tool 130 and the ^{of the tool 130} movement, ^{around the inner periphery of} in the peripheral direction, [of] the die 120 [the tool 130] are repeated. ^{By} [According to the] repetition of the above-stated process, the outer peripheral portion of

the ^{raw}material 50b is ^{progressively} moved ^{into the opening defined by} [in] the inner peripheral face of the female die 120. With this, ^athe squeezing processing is carried out. The axial direction of the tool 130 ^{represents the} [is a] squeezing processing direction. The ^{direction of} movement ^{direction} of the tool ^{130 circumferentially} [120] along ^{movement in the} [to] the inner peripheral face of the female die 120 is a radial direction of the tool 130.

According to this embodiment of the present invention, the ^{raw}material 50b is ^{progressively} deformed in a narrow portion between the female die 120 and the tool 130, ^{and,} since ^athe small and homogeneous strain is ^{applied} [given] incrementally, ^athe good flat face ^{on} [degree of] the bottom plate 51 can be maintained.

In addition to the above, since the flanges 52b, 52c, 52d are formed by restraining ^{the raw material 50b} [extending] over the ^{entire} [all] periphery thereof, the flanges 52b, 52c, 52d are not expanded ^{toward} [in] the outer side, ^{and a}the forming product having ^athe superior rectangular degree ^{between} [of] the flat plate portion and the flange portion can be manufactured.

In particular ^a[to], since the circular arc-shaped flange of the connection ^{relative} portion between the flange 52c and the flange 52d is made wide, ^{this process and} to the outer side according to ^athe forming, ^{but} since the flanges 52c, 52d are restrained, ^{relative} to the outer portion by the female die 120, ^athe vertical flanges 52c, 52d can be formed.

25 Namely, ^{over the entire} [in] the ^{range} from the begin^{ning} of the squeezing process to the finish process, since the flange is sandwiched between the inner peripheral face of the

female die 120 and the side face of the tool 130, the squeezing processing can be carried out by restraining the flanges from the outer portion and from the inner portion. As a result, ^athe processing ^{which ensures} ^{desired} (having) the accuracy (with) the rectangular degree etc. can be carried out.

As stated (in) above, in the increment ^{at} forming using the female die 120, the seat 140 is provided ^{inside the opening} (in the inner) (peripheral side) of the female die 120 and ^{the raw material 50b is fixed} to this seat 140, (the row material 50b is fixed to, the row material 50b can) ^{so that} (be fixed to, and) a predetermined forming ^{of the raw material 50b} can be attained. Further, ^{as} the forming proceeds, the flange is positioned in ^{contact with} the vertical face of the female die 120.

Further, the ^{inner corner at the top surface} (end portion) of the female die 120 is ^{continued toward} (moved to direct for) the inner peripheral face of the female die 120 ^{so that a} (and the) squeezing processing ^{can be} (is) carried out (r); and, further, the end portion of the female die 120 is positioned in the inner peripheral face of the female die 120 and the squeezing processing is carried out. Accordingly, ^a (the) good rectangular degree ^{between} (comprised of) the flange and the ^{portion} bottom face ^{formed} 51 can be obtained. Further, the height of the flange can be (formed) large.

Further, since the ^{peripheral} (end) portion of the ^{raw} (row) material 50b is moved ^{into} (in) the female die 120 ^{as} (and) the squeezing processing is carried out, when the fatigue ^{due to the} (of the after) forming of the ^{raw} (row) material 50b is taken into (the) consideration, after the forming, it is unnecessary to cut off the end portion of the flange.

Since ^athe high load as ^{experienced} shown in the press processing is not necessary, the female die 120 can be formed with the ^{a simple} easy material, such as ^athe general steel material, ^{so that} the thermal treatment, such as the sintering, and the minute surface finishing, such as ^{needed after use of a} the press metal die, are not necessary.

The movement of the tool 130 will be explained in ^{more} detail. The plate 50 has the flanges 52b, 52c, 52d ^{on} in the three sides of the ^{panel of} quadrangle ^{plan} shape and ^{on the fourth side} another one side no flange is provided. Accordingly, the circular arc portion of the shoulder ^{only} portion of the female die 120 is provided along ^{On the fourth} to the three sides. ^{upper surface} Another one side of the row raw material 50b is not mounted on the ^{rather, a} another one side of the female die 120. ^{therebetween} A gap is formed between the both.

The tool 130 moves ^{in the direction} to direct from the one end side of the flange 52b to the flange 52c and, through the flange 52c, the tool 130 moves ^{in the direction of} to direct to the end portion of the flange 52d. The ^{along which} move track of the tool 130, in the recessed portion 53 ^{moves} portion is shown in Fig. ⁸ 7.

In Fig. ^{has} 8, the tool 130 has moved along to the flange 52d and ^{is} passed through the end portion in the longitudinal direction of the flange 52d. Next, the ^a row raw material 50b is moved reversibly a little to position in the lower portion of the tool 130. Next, the seat 140 and the tool 130 are ^{lowered} descended. Next, the tool 130 is moved ^{so as} to reach the end portion in the longitudinal direction of the flange 52b through the flanges 52c, 52e ^{and} 52d, successively.

After the tool has passed the end portion of the flange 52b, as explained ^{with reference to} (in) Fig. 8, the ^{raw} (row) material 50b is moved reversibly a little to ^a position in the lower portion of the tool 130. Next, the seat 140 and the tool 130 are ^{lowered} descended. Next, the tool 130 is moved ^{so as} to reach the end portion in the longitudinal direction of the flange 52d through the flanges 52b, 52c ^{and} 52d. Hereinafter, the above stated operation is repeated.

Further, since the flange of the plate 50 is provided ^{on} only (the) three sides, the tool 130 is reciprocated as stated ^{statements} (in) above. The former ^{circumferentially} (explanations) "the tool 130 is moved in the peripheral direction along (to) the inner peripheral face of the female die 120" etc, include the case of ^{processing on} (the) three sides. Further, ^{even when} the flange is provided ^{on} only (the) three sides, it is unnecessary to reciprocate, but ^{this tool 130} (it) can go ^{all the way} around.

After the tool 130 has passed through the end portion in the longitudinal direction of the flanges 52d, 52b, ^{(to) with} movement of (move) the tool 130, the end portion in the longitudinal direction of the flanges 52d, 52b is sandwiched between the side face of the tool 130 and the inner peripheral face of the female die 120 ^{so that} (and) the end portion in the longitudinal direction of the flanges is formed with a predetermined shape.

(In the) ^{Midway} in the longitudinal direction of the flange, ^{when} the movement of the tool 130 is stopped, ^{since} the end portion (side) from there ^{does have a} (is) not (the) linear shape.

Between the end portion of the ^{raw} [row] material 50b having [the] no flange and the end portion of the female die 120, there is a gap [having] ^{of} more than ^{the} (a) radius of the tool 130. As the size of the above-stated recessed portion 53, it is
 5 necessary to have [the size] ^{a space} through which the tool 130 can [be] pass.

The [connection] portion between the flange 52b and the flange 52c is ^{removed} [separated]. Further, the recessed portion 53 ^{at this location} is arranged. The distance between the flange 52b and the
 10 flange 52c, namely, the size of the recessed portion 53, is determined ^{so as} to press the end portion in the longitudinal direction of the flanges ^{52b} 52b, 52c ^{using} [by] the side face of the tool 130 ^{against} [to] the inner peripheral face of the female die 120. The tool 130 is moved by pressing the end portion in the
 15 longitudinal direction of the flanges 52b, 52c.

When the tool ^{has} [is] moved from the flange 52b to the flange 52c, ^{and} the lower end of the tool 130 is ⁱⁿ contact ^{to} with the end face of the bottom plate 51, the tool 130 is ^{raised} [ascended] a little and is moved to the side of the flange
 20 52c ^{after which, the tool 130 is again} [and processed and] moved in the longitudinal direction of the flange. Namely, the tool 130 is moved as shown in Fig. 8.

The plate 60 is manufactured similarly. The plate 70 is manufactured similarly. The ^{movement} [move] of the tool 130 in the
 25 end portion in the longitudinal direction of the flanges 72b, 72c is carried out similarly.

The processing machine for carrying out the incremental ^{movement}

forming is a numeric control system processing apparatus,
 for example, ^{or a} NC milling machine or a machining center. ^{On} ~~To~~ a
 main shaft of the numeric control system processing
 apparatus, the tool 130 is installed. The tool 130 is moved ^{up and down}
 5 along ~~(to)~~ the inner peripheral face of the female die 20 in
 the vertical direction by ~~(the)~~ numeric control.

The main shaft ^{carrying} ~~(having)~~ the tool 130 is moved in the
 vertical direction and ~~(in)~~ one ^{way in the} ~~(direction)~~ horizontal
 direction. The female die 120 and the seat 140 are mounted
 10 on ~~(the)~~ ^a table (the base). The table is moved in the
 horizontal direction ^{in a} ~~(of the)~~ rectangular direction ^{relative to} ~~(against)~~
^{direction of} the ⁱⁿ ~~(direction of)~~ horizontal direction of the
 main shaft.

According to the above-stated two movements, the tool
 15 130 is moved along ~~(to)~~ the inner peripheral face of the
 female die 120. The ^{raising} ~~(ascending)~~ and ^{lowering} ~~(descending)~~ means 150 is
 mounted on the table. In place of the movement ^{in the vertical direction} ~~(in the)~~
~~(vertical direction)~~ of the tool 130, the table can be
^{raised} ~~(ascended)~~ and ^{lowered} ~~(descended)~~.

^{An} ~~(The)~~ example will be explained. ^{In this example, the} ~~(The)~~ diameter of the
 20 tool 130 is 25 mm, the plate thickness of the ^{raw} ~~(row)~~ material
 50b is from 0.5 mm to 4 mm degree, the distance from the
 inner peripheral face of the female die 120 to the side
 face of the tool 130 is from 0.8 times to 2 times degree,
 25 and the push-in depth ^{for} ~~(of)~~ one ^{incremental movement} ~~(time)~~ of the tool 130 (the
^{lowering at} ~~(descendant)~~ amount of one time of the seat 140) is 0.5 time
 to 2 times ~~(of)~~ the plate thickness of the ^{raw} ~~(row)~~ material 50b.

^{not R}
Further, the height of the flange is 20 mm, the radius^R of the circular arc (the shoulder portion) of the female die 120 is 5.5-13.5 mm, the diameter of the tool 130 is 25 mm, the radius of the tip end of the tool 130 is from 5.5 mm to 10 mm, and the radius of the circular arc portion 52e is 100 mm.

The size of the ^{raw} [row] material 50b will be explained. As shown in Fig. 7, the size of the ^{raw} [row] material 50b is such that the ^{edge} [end portion] of the ^{raw} [row] material 50b is positioned ^{on} ^{(female die 120 in line with the} [in] the upper portion of the center of a circular arc R of the shoulder portion of the female die 120, or the ^{edge} [end] portion of the ^{raw} [row] material 50b is positioned ^{toward} [to] the center ^{position} [side] of the female die 120 from the ^{raw} [upper portion] of the above-stated center. When the size of the ^{raw} [row] material 50b is larger^A than the above case, in the circular arc portion ^a [12a] of the flange [12], ^a [the] crack occurs easily in the connection portion between the flange [12] and bottom plate [11].

In the above-stated embodiment according to the present invention, after the seat 140 ^{has been lowered} [is descended], the tool 130 ^{lowered} [is descended], however the seat 140 and the tool 130 can be ^{lowered} [descended] at the same time. Further, the tip end of the tool 130 ^{need be} [is] not formed with ^a [the] flat shape, but can be formed with a spher^{ical} shape. Further, the tool can ^{provided so as} be [formed] to not rotate.

The squeezing processing can be carried out by fixing the seat 140 and ^{raising} [by ascending] the female die 120. The tool

130 does not move in the vertical direction, ^{during} ~~in~~ the midway ^{in this case} of the forming. The seat 140 is positioned ~~in~~ the position in the axial direction of the tool 130 and is arranged along ~~to~~ the inner peripheral face of the female die 120.

5 Further, ^{after} the tool 130 goes around ^{the circumference} along ~~to~~ the circular arc portion of the shoulder portion of the female die 130, ~~next~~ the tool 130 is moved ^{along} ~~in~~ the inner peripheral face of the female die 120, and ~~next~~ the tool 130 ^{moves} ~~goes~~ around ~~and~~ ^{the female die 120.} After the end portion of the ^{raw} ~~row~~ material is

10 formed with ^a ~~the~~ circular arc shape, ~~and~~ the tool 130 is ^{lowered} ~~descended~~ along ~~to~~ the inner peripheral face of the female die 120 ^{even} ~~accordingly~~, the height of the flange is made ^a ~~further~~ larger.

^{an} ~~The~~ embodiment according to the present invention, as

15 shown in Fig. 11 and Fig. 12, will be explained. A plate 250 (260) corresponding to the plate 50 (60) is constituted by ~~the~~ ^{an} extruded frame member. The extruded frame member 250 (260) has plural ribs 255 (265). This extruded frame member 250 (260) is ^{subjected to incremental forming} ~~carried out the increment formation~~.

20 For this ^{purpose} ~~reason~~, ~~the~~ ribs 255 (265) of the upper end portion and the lower end portion ^{of the ribs 255 (265)} of the extruded frame member 250 (260) ^{are} ~~is~~ removed by ^{being} ~~the~~ cut off.

When the thickness of the plate ^{at} ~~of~~ the upper end portion and the lower end portion of the extruded frame

25 member 250 (260) and the portion of the side face ~~side~~ of the car body (the portion for providing the flange 252 (262)) is thick ~~and~~, the face of the rib 255 (265) is cut

off [and then] ^{so that} the plate thickness becomes ^{suitably} [to suit] for [the] increment ^{al} forming.

To the end portion of the side of the plate 270 and the end portion of the side of the passage 45, ^a [the] rib 257 (267) is provided. The ^{edge} [portion] of the end portion 259 of the plate 250 ^{is cut off and a welding groove is provided} for welding to the end portion of the plate 270 [is cut off and the welding use groove is provided].

^{The size of the} [A] protrusion [size] of the rib 257 (267) is smaller than ^{the size of the} [a] protrusion [size] of the rib 255 (265). A groove 258 is provided ⁱⁿ [to] a plate of the rib 257 (267). ^{the} [An] end portion 259 of the plate is arranged ^{at} the side of the passage 45 from an end portion of the side of the passage 45 of the rib 257 (267).

^{the} In the groove 258, an end portion of an interior member (not shown in ^{is inserted,} figure) ^{the} and by [the] provision of the rib 257 (267), ^{the} [a] plate thickness of the end portion of the side of the passage 45 is made thick ^{of} [it]; as a result, the strength ^{of} [corresponding] the flange 255 (265) can be secured.

For this reason, the end portion of the side of the passage 45 is not formed with the rib 257 (267), but the plate thickness of the end portion of the passage 45 side can be formed thick. Further, the flange 255 (265) can be provided ^{by use of} [according to the] extrusion processing [manner]. A thick portion is ^{designated} [named] generically with ^{respect to} the rib 257 (267), the thick plate member and the flange 255 (265).

According to the above ^a stated embodiment of the present invention, it is unnecessary to provide ^a [the] member

(by bending the flange) corresponding to the flange 52b (62b). ^{by bending a flange}

Further, it is unnecessary to provide the recessed portion

53. Accordingly, the plate can be formed easily.

The plate 70 can be formed with ^{an} [the] extruded frame member similar ~~to~~ to the plate 250. The extrusion direction of the plate 70 is the width direction of the car body. The flange 72b is formed in the thick portion of the plate 250 (260). Further, the combination of the plate 220 to the plate 270 can change the combination of the plate 50 to

10 the plate 70.

In a case where the plate 250 is not constituted by one extruded frame member, ^{it is possible to use} [using] plural extruded frame members ^{that} are welded. This joining (the welding) can be carried out, for example, ^{using} [according to the] friction stir welding [manner]. The plate 270 can be formed [with the] ^{of an} extruded frame member.

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^{It is possible to mount a} [The] male die [is mounted] on the ^{raw} [row] material and, the outer peripheral portion of the ^{raw} [row] material ^{using a} [is bent] by the tool ^{moving} along [to] the outer peripheral portion of the male die ^{in manufacture of a} [and then] the flange [can be manufactured]. Further, the

20 plates 50, 60, 70 can be manufactured [according to the] ^{using} press processing [manner].

According to the present invention, the two [forming] products having ^a [the] flange in the end portion of the plate and ^a [the] third plate can be welded without ^a [the] gap (the clearance).

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